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Cost-Benefit Analysis of USAID/Mali's Sorghum and Millet Value Chain Interventions Final Report

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Cost Benefit Analysis of USAID/Mali's Sorghum and Millet Value Chain Interventions

Final Report

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LIST OF ACRONYMS

AKF	Aga Khan Foundation
AOPP	Association des Organisations Professionnelles Paysannes
CBA	Cost Benefit Analysis
CMDT	Compagnie Malienne pour le Développement des Textiles
CRS	Catholic Relief Services
DRA	Direction Régionale de l'Agriculture
ENPV	Economic Net Present Value
EUCORD	European Cooperative for Rural Development
FEP	Foreign Exchange Premium
FNPV	Financial Net Present Value
FtF	Feed the Future
GoM	Government of Mali
ICRISAT	International Crops Research Institute for the Semi-Arid Tropics
IER	Institut d'Economie Rurale
IIA	Integrated Investment Appraisal
IRR	Internal Rate of Return
MALIMARK	Mali Agricultural Market Trust
MERR	Modified Economic Rate of Return
MIRR	Modified Internal Rate of Return
MT	Metric Tone
NPV	Net Present Value
SOGEA	Société Générale d'Agrochimie

USAID	United States Agency for International Development
USD	United States Dollar
VC	Value Chain

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EXECUTIVE SUMMARY

USAID has been supporting development of agriculture and improvements in food security in many countries in sub-Saharan Africa through technical assistance under its Feed the Future (FtF) program. In an effort to evaluate these programs, USAID has begun a process of conducting cost benefit analyses (CBAs) of the various activities currently in process or already completed. To support this process, USAID/Washington contracted International Development Group LLC (IDG) to conduct several of these CBA activities through the Learning, Evaluation and Analysis Project-II (LEAP-II). This report presents the findings of the CBA of USAID/Mali's work with sorghum and millet value chains (VCs). The analysis looks at evaluating the recent FtF activities implemented under the Africa RISING' large-scale diffusion of technologies for sorghum and millet systems (ARDT_SMS) project.

ARDT_SMS falls within a larger portfolio of U.S. Government interventions in Mali to improve food security through the Feed the Future initiative. The project commenced in 2014 and will be completed in 2017. The ARDT_SMS project was implemented in line with Government of Mali (GoM) development strategies toward achieving the food security of small farmers and national self-sufficiency in sorghum and millet production. The ARDT_SMS aims to increase production and incomes for sorghum and pearl millet farmers.

The ARDT_SMS project is focused in two regions of the country, Sikasso (sorghum VC) and Mopti (millet VC). The two main activities of the ARDT_SMS projects are:

1. Establishment of the farmers' field schools to enhance farmers' knowledge of new sorghum and millet production technologies;
2. Establishment of demonstration plots to demonstrate the potential productivity of utilizing new productive technologies;

Phase II of the ARDT_SMS project will aim to increase access to improved inputs such as certified seeds, fertilizers, and fungicides. Phase II of the project, however, is out of scope of this CBA.

Production technologies promoted by the project allow farmers to increase yield of millet by up to 30 percent. In addition, the project introduced the intercropping of millet with cowpeas, allowing farmers to not only to increase millet yield but to harvest two crops. As a result, the annual income of the millet farmers has increased from 27 to 126 USD/hectare (ha).

Sorghum production in the Sikasso region has declined gradually over the last 10 years. Government and donor promotion of cotton and maize production can partially explain this trend. However, the analysis also revealed that existing production technology results on marginal financial benefits (FNPV 194.6 USD/ha), which explains the phenomena. The production technologies introduced by the project allow farmers to increase sorghum yield by 60 percent. As in the millet VC, the project introduced intercropping of sorghum with cowpeas. The annual income of farmers increased from 50 USD/ha to 115 USD/ha.

Despite the potential of new production technologies to improve the households' income, limited attention of the ARDT_SMS project on other than productivity related issues, such as market access, access to micro credits, and etc. raises the major concern. The analysis, therefore, assumes that only 50% of the targeted households will adopt the production practices introduced by the ARDT_SMS project. Under this assumption the project has produced positive financial and economic returns, with an ERR of 25 percent and an ENPV of USD 19.29 million.

Table 1. Summary Impact Figures

	ERR ¹	ENPV ²
Impact Mali Country Perspective	N/A	USD 28.76 mill
Present Value of USAID Investment		USD 9.47 mill
Impact USAID Perspective	25 %	USD 19.29 mill

The analysis also revealed significant fiscal savings due to reduced subsidy on fertilizers, which can be attributed to the project. Maize production is dominant in the Sikasso region; therefore, the CBA assumes that 60 percent of area affected by the project will shift from maize to improved sorghum. In contrast to maize, sorghum cultivation requires lower fertilizers and other chemicals application. In addition, currently sorghum producers are not able to benefit from the 50 percent price subsidy on fertilizers. The annual fiscal savings for the GoM from reduced subsidy requirement are estimated at 1,097,748 USD. The PV over project life amounts to 9.18 million USD. Moreover, the project led to positive environmental impacts due to reduced fertilizer consumption.

The analysis makes four key recommendations:

1. **Expand GoM subsidy of fertilizers.** The GoM provides a 50 percent subsidy on chemical fertilizer (Sikasso region) used for production of cotton, maize and rice. A significant number of project beneficiaries are expected to shift from cotton and maize production to the improved sorghum production, therefore, releasing fiscal pressure. It is recommended to include sorghum into the list of crops that can obtain subsidies on fertilizers. Such a measure will allow farmers to increase annual income from 115 to 134 USD/ha. This additional financial incentive will boost the scaling up dissemination of the production technologies.
2. **Assure access to hybrid and improved seed varieties.** The problem of cultural reluctance of farmers to purchase seeds for their production should be addressed by the project.³ Currently, the project provides free sorghum and millet seeds to attendants of field schools and farmers have limited exposure to purchasing seeds directly from the market. With Phase II, the project is expecting to improve access to high quality seeds by increasing seed production. Farmers, however, have only one farm period to begin purchasing seeds directly from the market before the anticipated project end date. This is a very short period for addressing any problems that may

¹ Internal Rate of Return (IRR) is the (break-even) interest rate at which investors can expect to receive positive returns. The Economic Rate of Return (ERR) differs from the Financial Rate of Return (FRR) in that it takes into account the effects of factors such as price controls, subsidies, and tax breaks to compute the actual cost of the project to the economy.

² In finance, the net present value (NPV) is defined as the sum of the present values (PVs) of incoming and outgoing cash flows over a period of time. Economic Net Present Value (ENPV) then looks at incoming and outgoing resources which are defined beyond just cash flows and are described as benefit and cost resource flows, respectively.

³ “Seed Value Chains for Sorghum and Millet in Mali”, International Food Policy Research Institute, 2008, pg 14-15. Farmers tend to use their own seeds based on history, culture and traditional knowledge. Farmers also tend to be generally risk averse in trying new methods without seeing results first and cash poor at the time of planting. These factors also influence decisions of producers to purchase seeds rather than use their own.

arise in this process and can potentially threaten sustainable access to new seed varieties.

3. **Facilitate coordination at the implementing partner level.** Coordination of activities between current project implementing partners is fairly weak, resulting in a “silo approach” to project implementation in certain areas, which can reduce efficiency and overall impact of project. In the 2014-15 farm year, there were instances of the same farmer in the Sikasso region receiving ARDT_SMS project training from two different implementing partners and with two different methodologies. This risk can be managed by introducing consultative platforms for partners working in the same region and at the lead implementing partner level (such as through ICRISAT).
4. **Leverage synergies with other projects carrying out similar work in the Sikasso and Mopti regions.** Adoption of new technologies requires a certain level of commitment by farmers to change current production practices. This commitment can only be obtained when farmers have access to all required inputs, including access to credit and access to markets to sell their production. Limited attention of the ARDT_SMS project on issues other than productivity raises major concerns.

INTRODUCTION

PROJECT DESCRIPTION

The United States Agency for International Development (USAID) has requested a cost-benefit analysis (CBA) of USAID/Mali's Africa RISING large-scale diffusion of technologies for sorghum and millet systems (ARDT_SMS), implemented over the 2014-17 period. The project is being implemented within specific Feed the Future (FtF) intervention areas in the Mopti (millet VC) and Sikasso (sorghum VC) regions of Mali.

The ARDT_SMS project's overall goal is to increase incomes for sorghum and pearl millet farmers by raising the productivity and profitability of these two cereals. Project activities are guided by two specific objectives. First, to enhance male and female farmers' knowledge of new sorghum and millet production technologies. Second, to facilitate male and female farmers' access to the improved seeds, fertilizers, and fungicides.

FtF's Mali has selected sorghum and millet VC as priority VCs due to high per capita consumption of the crops. In addition, both of the crops have a good level tolerance for local climatic conditions (irregular rainfall and low soil fertility).

The ARDT-SMS project designs strategies and technologies to ensure success for those who are often margin to the sorghum and millet value chains, most of the times, women and children. Increased productivity under the activities of the ARDT_SMS project, therefore, creates more opportunities to directly impact the livelihoods of the rural poor, particularly women and children. This is consistent with the Government of Mali's (GoM) increasing focus on cereal production and the resilience of vulnerable households.

The CBA was conducted on the basis of data and information collected through interviews with ARDT_SMS implementing partners, beneficiary farmers and other stakeholders in the VCs. A comprehensive literature review was conducted to verify the collected information and fulfil data gaps. A detailed list of the stakeholders interviewed is provided in Annex A.

DESCRIPTION OF INTERVENTIONS

The focus of the ARDT_SMS project is on the diffusion of technologies of proven efficacy for enhancing sorghum and pearl millet production systems under the environmental and socio-economic realities of Malian farmers. The major agro-ecological and production system differences in the Mopti and Sikasso regions as well as the presence and capabilities of different implementing partners led to the development of two different approaches for the Sikasso and Mopti regions. Interventions in Mopti are focused on productivity of the millet crop, while those in Sikasso target the sorghum crop.

Catholic Relief Services (CRS), Direction Régionale de l'Agriculture (DRA)-Mopti (Ministry of Agriculture) and Aga Khan Foundation (AKF) are the lead implementing partners in the Mopti region with support from other partners, such as International Crops Research Institute for the Semi-Arid Tropics (ICRISAT), Société Générale d'Agrochimie (SOGEA), Institut d'Economie Rurale (IER), and input dealers and farm seed producer organizations. Specific technologies being diffused to improve productivity of the millet crop in Mopti include:

- Introduction of improved varieties and hybrids of millet.

- Seed treatment for controlling early season insect pests and diseases using fungicides
- Introduction of intercropping of millet with cowpea
- *Weed* management and micro dose application of fertilizers
- Biological Control of the millet head miner

Compagnie Malienne pour le Développement des Textiles (CMDT)-Koutiala, CMDT-Sikasso, CRS and DRA-Sikasso are the main implementing partners in the Sikasso region, with an active participation of other partners, such as AOPP, MALIMARK, EUCORD, ICRISAT and IER. The specific technologies used to improve the sorghum crop are similar to the activities in millet VC with the exception that biological control of head miner is not applicable in the sorghum VC.

METHODOLOGY

The Integrated Investment Appraisal (IIA) model offers a means of evaluating both the financial and the socio-economic effectiveness of an investment project, estimating its impact from various perspectives. IIA is the only single-model approach to quantify the impact of every project-related transaction, from the private investor to tax revenues, fiscal expenditure, consumers, and the environment. The methodology is used in project evaluations by major development banks, donor agencies, and public investment units.

Alternative forms of impact analysis entail discrete financial analyses and assessments of economic impact, which are often carried out by independent analysts at different stages of project development, and which therefore rarely provide an opportunity for experts to adjust and improve project design.

The IIA of USAID's ARDT_SMS project begins with an evaluation of the profitability of the investment (financial module). This analysis is conducted on an incremental basis to determine the net incremental impact of the project on various stakeholders, including project beneficiaries, and to test the project's financial sustainability. The socio-economic assessment (economic module) builds on the financial module, greatly reducing the time and resources normally required for such studies. The economic module is based on the principles of applied welfare economics,⁴ according to which socio-economic benefits are assigned monetary values and assessed using typical investment project efficiency indicators, such as economic net present value (ENPV), analogous to financial net present value (FNPV), and economic rate of return (ERR), analogous to internal rate of return (IRR).

MODEL DESCRIPTION

The analysis is applied to a 20-year evaluation period, 2014-34, and compares "with-project" and "without-project" scenarios on an incremental basis, with real financial and economic discount rates set at 12 percent.⁵ The model is constructed on an annual basis with a base year of 2015 and results are expressed in 2015 prices. The model first derives nominal cash flows, which are then discounted using corresponding price indexes to derive real cash-flow statements. The analysis uses World Bank inflation and exchange rate data.

⁴ See "Three Basic Postulates for Applied Welfare Economics", A. Harberger, 1971.

⁵ USAID set the 12% rate for both the economic and financial model.

Cereal production costs are usually expressed on a per-hectare basis. As a result, the farm models were constructed on a per-hectare basis. The CBA model starts with an analysis of millet and sorghum production, comparing the profitability of production in the “without-project” and “with-project” scenarios. The “without-project” scenario for millet producers is assumed to be local millet production, while the “without-project” scenario for sorghum producers is assumed to be the combination of maize and local sorghum production with the share of 60% and 40%, respectively.⁶ Impact of a change in this assumption is presented in the Sensitivity Analysis section of this report.

Farmer cash-flow profiles provide the basis for subsequent economic, stakeholder, and risk analysis of millet and sorghum farming activities. The Monitoring and Evaluation indicators on the total land surface affected by ARDT_SMS project is used to derive an aggregate economic resource flow statement. The baseline analysis assumes that the project would be able to achieve only 50% of the M&E target. The rationale for this assumption is discussed in details in Sensitivity and Risk Analysis section. USAID investment cost is then compared with the net incremental economic benefits of the ARDT_SMS project to derive the net present value (NPV) of the USAID investment.

⁶ This assumption is based on field observations in the Sikasso region.

FINANCIAL ANALYSIS

The team collected primary data for the financial analysis was collected during a trip in December 2015. Consultations with agricultural experts and implementers of the ARDT_SMS project, as well as a literature review, informed data analysis and adjustment. With these findings, the team developed a set of farm budgets for the “without-project” and “with-project” scenarios (see Annexes C to G). The farm budgets were prepared based on mean values, excluding statistical outliers from the analysis.

A summary of the incremental financial analysis of the ARDT_SMS project is presented in Table 2 (below). The adoption of new production methods promoted by the ARDT_SMS project is expected to result in positive financial returns for sorghum and millet farmers.

Table 2. Incremental Financial Analysis (USD)

ARDT_SMS Beneficiaries	FNPV/Ha	IRR	Total FNPV
Millet producers	710.00	32%	15.18 mill
Sorghum Producers	482.38	37%	10.31 mill
Total			25.49 mill

In the millet VC, annual income of farmers has increased from 27.38 USD/ha to 125.53 USD/ha, a more than 450 percent increase for farmers. This translates into incremental FNPV of USD710 per hectare. The total incremental FNPV⁷ from the millet farmers’ perspective is USD15.2 million, assuming an adoption rate of 50 percent for the new millet varieties. The incremental IRR is 32 percent.

In the sorghum VC, the analysis uses a counterfactual crop for sorghum, assuming farmers allocate 60 percent of their land to growing maize and 40 percent to growing local sorghum varieties. Under this assumption the annual income of farmers has increased from 49.53 USD/ha to 115.17 USD/ha, a 233 percent increase. The FNPV per hectare is USD721.70 for “with-project”, compared to USD239.32 in the “without-project” scenario. The incremental FNPV is USD482.38 per hectare and IRR is 37 percent. The total incremental FNPV⁸ from the sorghum farmers’ perspective is USD10.31million.

Currently, maize producing farmers in the Sikasso region benefit from the 50 percent subsidy on fertilizers. The improved sorghum production technologies introduced by the project are financially more profitable for farmers than maize production.⁹ Given current dominance of the maize production in the region, the analysis assumes that 60 percent of the area affected by the project will shift from maize to improved sorghum. Sorghum producers, however, are not able to benefit from the 50 percent price subsidy that is available for other crops through CMDT. If the GoM will provide equivalent subsidy on fertilizers for sorghum, the

⁷ Total number of hectares covered by the project is assumed to be 21,382.

⁸ Total number of hectares covered by the project is assumed to be 21,382.

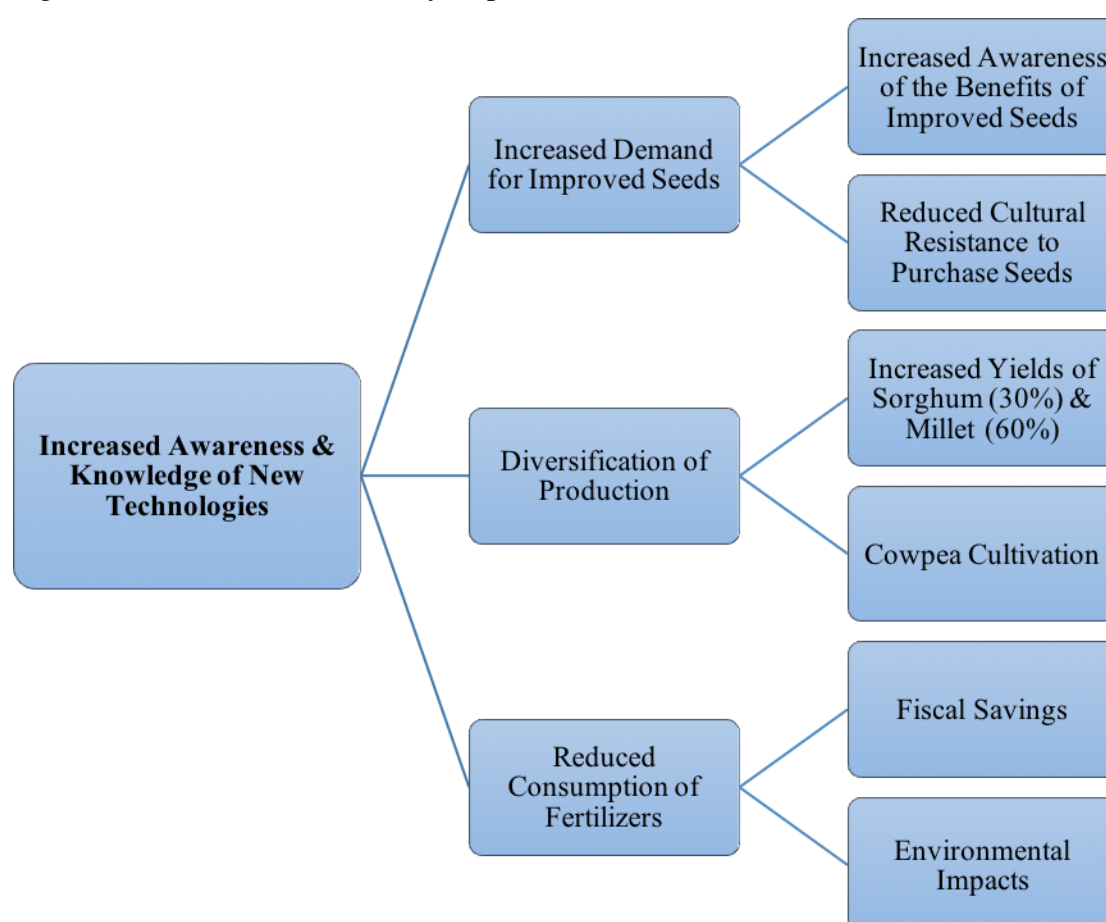
⁹ FNPV for maize production find out to be 465 USD/ha comparing to 722 USD/ha for improved sorghum.

incremental FNPV per hectare will increase to USD638.99. The annual income will become 133.89 USD/ha, rising from 115.17 USD/ha with no subsidy.

BENEFITS OF ARDT_SMS PROJECT INTERVENTIONS

Dissemination of knowledge of improved production practices resulted in a number of benefits in the sorghum and millet VCs. Figure 1 presents the main benefits of the project activities.

Figure 1. Benefits of Productivity Improvement Interventions



Increase in Yields

The project interventions have increased average yields of millet and sorghum. Millet yields have increased from 0.93 MT/ha to 1.2 MT/ha. Average sorghum yield has increased from 1.0 MT/ha to 1.6 MT/ha. The provision of seeds, seed treatment and mineral fertilizer facilitated the immediate application of new production methods in a peer-to-peer learning environment.

Increased Demand for Improved Seeds

Phase I of project implementation has been successful in generating interest among farmers in the different improved seed varieties being diffused. Farmers that completed training programs were convinced of the benefits of using improved inputs. This in turn helped to reduce the cultural reluctance to purchase any types of seeds. During farmer interviews, however, access to larger quantities of improved seed varieties beyond the life of project was frequently cited as a constraint to long term adoption of new technologies.

As the project enters Phase II of implementation, with emphasis on training new seed producers, it is clear that some level of excess demand for these new seed varieties has already been established through successful awareness and knowledge improvement interventions. This increases the likelihood of having sufficient demand when additional improved seed varieties enter the market.

Benefits of Intercropping

The project introduced intercropping of sorghum and millet with cowpeas. Cowpeas can efficiently be intercropped with sorghum and millet with limited reduction in the yields of the main crop. In the millet VC, the value of cowpeas harvest is estimated at 54.5 USD/ha. This corresponds to a 55 percent increase in the annual income of millet producing farmers.

In case of the sorghum VC, the net benefit from cultivating cowpea is 72.6 USD/ha. This is higher than the estimated total increase in the annual income of 65.0 USD/ha, indicating that without intercropping farmers have no incentive to switch from maize production to improved sorghum production.

Reduced consumption of fertilizers

Maize production is dominant in Sikasso region. Therefore, the CBA assumes that 60 percent of the area affected by the project will shift from maize to improved sorghum. In contrast to maize, sorghum cultivation requires less fertilizers and other chemicals. In addition, currently sorghum producers are not able to benefit from the 50 percent price subsidy on fertilizers. The annual fiscal savings for the GoM from reduced subsidy requirement are estimated at 1,097,748 USD. The PV over project life amounts to 9.18 mill USD. Moreover, positive environmental impacts can be attributed to the project due to the reduced fertilizer consumption.

INCREMENTAL COSTS TO THE MILLET FARMERS

Total costs for millet farmers have increased by 58 USD/ha. This moderate increase in the cost seems to be reasonable, however, given low purchasing power of the farmers, as access to microfinance still remains the issue. The major cost contributors are improved seeds and labor. Table 3 presents the summary of farm level expenditures. For more detailed breakdown of costs and benefits at the farm level, please see the farm budget for local and improved millet provided in the Annexes C and D.

Table 3. Farm Level Expenditures (Millet, USD/ha)

Cost	Without Project (Local Millet)	With Project (Improved Millet)	Incremental
Seeds	2.6	22.6	20
Labor	117.9	136.7	18.8
Other costs	102.5	121.7	19.2
Total	223.0	281.0	58.0

INCREMENTAL COSTS TO THE SORGHUM FARMERS

Total costs for sorghum farmers have increased by 32.5 USD/ha. As in the millet VC, the major cost contributors are improved seeds and labor. It should be noted that significant direct cost savings result from reduced consumption of fertilizers and herbicides. Table 4 summarizes of farm level expenditures.

Table 4. Farm Level Expenditures (Sorghum, USD/ha)

Cost	“Without-project” (Maize & Local Sorghum)	“With-project” (Improved Sorghum)	Incremental Costs
Seeds	4.7	36.5	31.8
Fertilizer	77.9	39.8	(38.1)
Herbicide & Fungicide	21.0	15.1	(5.9)
Labor	174.6	219.6	45
Other costs	13.3	13.0	(0.3)
Total	291.5	324	32.5

ECONOMIC ANALYSIS

The financial analysis outlined above forms the basis for an economic assessment of ARDT_SMS investments. Economic analysis examines the incremental costs and benefits of project activities in terms of their broader impact on the society. Economic analysis takes into account various distortions that are present in the economy. Market prices frequently do not correspond to the actual value of resources produced and consumed in the course of a given activity due to distortions such as taxes and subsidies.

The GoM exempts all chemical products and agricultural equipment from value added tax (VAT), and it subsidizes fertilizers destined for maize in the Sikasso region, and fertilizers destined for millet plots in Mopti region.

The analysis treats cowpeas, maize, sorghum and millet as importable project outputs. The conversion factor¹⁰ for maize, sorghum, millet and cowpeas is estimated at 0.84.

The following distortions exist:

- the foreign exchange premium (FEP), which is estimated at 7.02 percent for Mali,¹¹
- VAT and import duty on imported agricultural products (18 percent and 7.5 percent, respectively).

Mali exports mixed mineral and chemical fertilizers, exporting principally to China, India and Burkina Faso. As a result, fertilizers are treated as exportable inputs. The only distortion on non-subsidized fertilizers is the foreign exchange premium (FEP). For subsidized fertilizers, conversion factor arrives at 2.04 while fertilizers with no subsidy have 1.07 as a conversion factor.

The analysis presented here uses commodity-specific conversion factors to adjust cash flows and derive net resource flows from millet and sorghum producers. The net resource flows are then scaled up, according to the acreage of land surface affected by ARDT_SMS activities, to capture total net economic benefit.¹²

The following tables present a summary of the incremental economic analysis from Mali's and USAID perspectives.

Table 5. Incremental Economic Analysis of ARDT Project

ARDT Beneficiaries	ENPV/Ha (USD)	ERR	Total ENPV (USD millions)
<i>Millet producers</i>	492.61	29%	10.53
<i>Sorghum Producers</i>	833.11	N/A	18.14
<i>TOTAL ENPV (Mali Perspective)</i>			28.67

¹⁰ Conversion factors are constructed for transforming financial prices into corresponding economic values.

¹¹Kuo, 2014

¹² See Annex B for a complete set of conversion factors used in the analysis.

ARDT Beneficiaries	ENPV/Ha (USD)	ERR	Total ENPV (USD millions)
<i>PV of USAID Investment</i>			9.47
<i>ENPV USAID Perspective</i>			19.20
<i>MRR USAID Perspective</i>			25%

USAID investment in the millet and sorghum VCs amounts to USD 11 million (50 percent in the millet VC and 50 percent in the sorghum VC) in nominal terms. The PV of this cost is USD 9.47 million, which is deducted from the PV of net economic benefits from Mali's perspective to calculate the ENPV of the ARDT project from the USAID perspective.¹³ The ENPV from USAID prospective is USD 19.20 million using a 12 percent economic opportunity cost of capital. The ERR is 25 percent.

¹³ The PV and NPVs are expressed as of 2014, the year the ARDT project commenced.

STAKEHOLDER ANALYSIS

The social analysis of the project estimates the distribution of income changes caused by the project. This distributive analysis includes the reconciliation of financial, economic, and distributional appraisals, as well as identifying project impacts on principal objectives of the society concerned. There are four main stakeholders associated with the ARDT project:

1. Sorghum producers (Sikasso region)
2. Millet producers (Mopti region)
3. Government of Mali
4. USAID

The financial gains to sorghum producers and to millet producers are reported as the corresponding FNPV in the financial analysis section. The cost of USAID investments is nominal at USD11 million over the life of the ARDT project. This translates into a PV of USD9.47 million with the discount rate at 12 percent.

Government Net Externalities are FEP savings from reduced cereal imports, but also fiscal losses through taxes (VAT and import duties) and direct costs through fertilizer subsidies for the millet value chain.

The following table presents the results of distributive analysis.

Table 6. Distributive Analysis (USD millions)

Stakeholder	PV of Gains/Losses
Sorghum producers	10.31
Millet producers	15.18
USAID Investment	(9.47)
Government of Mali – Total	3.26
<i>Government Net Externalities- Millet VC</i>	<i>(4.65)</i>
<i>Government Net Externalities- Sorghum VC</i>	<i>7.91</i>
Total	USD 19.29 mill

SENSITIVITY AND RISK ANALYSIS

The sensitivity analysis tests the impact of changes to the main assumptions and parameters of the analysis on the deterministic returns of ARDT_SMS project interventions. The sensitivity analysis was conducted on key variables. While some variables are presented below, more sensitivity tables are available in the Excel model that accompanies this report. The team conducted a sensitivity analysis on a number of variables including:

1. Change in the adoption rates of the hectares under improved technologies for both millet and sorghum;
2. Change in the yields in the “with-project” scenario;
3. Change in the price of fertilizers;
4. Change in the yields in the “without-project” scenario.

Table 7. Impact of change in adoption rates on ENPV from USAID's perspective (million USD)

		Adoption rate (Millet)						
		10%	20%	30%	50%	60%	80%	100%
Adoption rate (Sorghum)	10%	(3.72)	(1.61)	0.49	4.71	6.81	11.03	15.24
	20%	(0.07)	2.03	4.14	8.35	10.46	14.67	18.88
	30%	3.57	5.68	7.78	12.00	14.10	18.32	22.53
	50%	10.86	12.97	15.07	19.29	21.39	25.60	29.82
	60%	14.50	16.61	18.72	22.93	25.04	29.25	33.46
	80%	21.79	23.90	26.01	30.22	32.33	36.54	40.75
	100%	29.08	31.19	33.29	37.51	39.61	43.83	48.04

The baseline scenario assumes a 50 percent adoption rate for both the millet and sorghum VCs. An impact of simultaneous changes in the adoption rate in each of the VCs is presented above. The project return reaches its maximum of USD 48.04 million if the adoption rate in both VCs is 100 percent. A 20 percent adoption rate is the breakeven point for the ENPV from USAID’s perspective. The adoption rate, therefore, has to be closely monitored by the M&E unit of the project.

Table 8. Yield of improved millet (Kg/Ha)

		Aggregate Incremental FNPV (Million USD)	Incremental ENPV (Million USD)	
		Millet	Economy	USAID
977	5%	5.49	2.39	(2.35)
1,023	10%	7.51	4.08	(0.65)
1,070	15%	9.53	5.78	1.05
1,116	20%	11.55	7.48	2.74
1,200	29%	15.18	10.53	5.80

The baseline analysis assumes a 29 percent increase in yield of millet if farmers use improved millet seeds and suggested production technologies. If increase in the yield of millet only reaches 12 percent, total ENPV from USAID's perspective for millet farmers will become negative. Financial NPV will also drop to USD 8.30 million.

Table 9. Yield of cowpeas in the millet VC (Kg/Ha)

		Incremental FNPV (Million USD)	Incremental ENPV for millet (Million USD)	
		Millet	Economy	USAID
160	-20%	12.59	8.34	3.61
170	-15%	13.24	8.89	4.16
180	-10%	13.88	9.44	4.70
190	-5%	14.53	9.99	5.25
200	0%	15.18	10.53	5.80

Farmers are intercropping cowpeas with improved sorghum. Economic NPV from USAID's perspective for millet farmers may drop by 19 percent if the yields of cowpea seeds drop by 10 percent.

Table 10. Yield of improved sorghum (Kg/Ha)

		Incremental FNPV (Million USD)	Incremental ENPV (Million USD)	
		Sorghum	Economy	USAID
1,300	30%	(0.04)	9.49	4.75
1,400	40%	3.41	12.40	7.66
1,500	50%	6.86	15.31	10.58
1,550	55%	8.59	16.77	12.03
1,600	60%	10.31	18.22	13.49

The financial and economic returns are highly sensitive to the change in the yield of improved sorghum, indicating that it should be closely monitored. The baseline assumption is that project beneficiaries will experience a 60 percent increase in the yield of sorghum. Financial NPV will turn into negative if this increase drops by half to 30 percent. This will cause the production of improved sorghum to become financially unfeasible for the farmers. It should be noted that there is significant subsidy on fertilizers used for maize cultivation. In addition, quantity of fertilizers required for maize is significantly above the quantity demanded by sorghum. Although the FNPV becomes negative if the increase in sorghum yield drops, the ENPV still remains positive due to the significant savings of fiscal resources.

Table 11. Yield of cowpea residues (Bundle/Ha)

		Incremental FNPV (Million USD)	Incremental ENPV for sorghum farms (Million USD)	
		Sorghum	Economy	USAID
640	-20%	6.98	15.41	10.68
680	-15%	7.81	16.11	11.38
720	-10%	8.65	16.82	12.08
760	-5%	9.48	17.52	12.78
800	0%	10.31	18.22	13.49

Farmers intercrop cowpea with improved sorghum. In case of sorghum VC, the value of residues from cowpeas used to feed cattle is the main benefit. The analysis assumes that 800 bundles of residues can be harvested per hectare. A decrease in the quantity of cowpeas produced can negatively affect both FNPV and ENPV to the extent that a 10 percent decrease in the yield can result in a 16 percent decrease in the financial NPV and 10.5 percent decrease in the economic NPV from USAID's perspective.

Table 12. Change in price of fertilizers

	Incremental FNPV (Million USD)		Incremental ENPV (Million USD)	
	Millet	Sorghum	Economy	USAID
0%	15.18	10.31	28.76	19.29
10%	15.04	10.53	29.61	20.14
20%	14.91	10.75	30.46	20.99
30%	14.77	10.96	31.32	21.85
40%	14.63	11.18	32.17	22.70
50%	14.50	11.39	33.03	23.56

In case of the millet VC, incremental costs of fertilizers are positive since more fertilizer is needed with improved millet. As a result, the increase in fertilizer costs has a negative influence on FNPV for millet farmers. Sorghum farmers experience the opposite. They become better off with an increase in price of fertilizers since the incremental cost of fertilizers is negative and it acts as a cost saving for those farmers. Economic NPV from USAID perspective increases overall with increases in the price of fertilizers.

Table 13. Change in the yields in the without-project scenario

	Aggregate Incremental FNPV (Million USD)		Aggregate Incremental ENPV (Million USD)	
	Millet	Sorghum	Economy	USAID
0%	15.18	10.31	28.76	19.29
1%	12.67	6.96	23.80	14.33
2%	10.30	4.64	19.85	10.38
3%	8.91	3.03	17.32	7.85
4%	8.05	1.92	15.65	6.18
5%	7.46	1.15	14.50	5.03

The growth in the yields in the “without” project scenario is assumed to be 0 percent as a base scenario for this analysis. Higher growth rates will decrease financial and economic returns of ARDT_SMS project. However, it is important to note that an improvement in the yields in “without” project always comes with an incremental cost, which was not taken into account in this analysis.

CONCLUSIONS AND RECOMMENDATIONS

ARDT_SMS project has produced positive economic returns, with an ERR of 25 percent and an ENPV of USD 19.29 million. The annual income of the millet farmers has increased from 27 to 126 USD/ha. In the sorghum VC, the annual income of farmers has increased from 50 USD/ha to 115 USD/ha.

Another important finding of the analysis is that significant fiscal savings due to reduced subsidy on fertilizers can be attributed to the project. Maize production is dominant in Sikasso region; therefore, the CBA assumes that 60 percent of area affected by the project will shift from maize to improved sorghum. In contrast to maize, sorghum cultivation requires less fertilizer and other chemicals application. In addition, currently sorghum producers are not able to benefit from the 50 percent price subsidy on fertilizers. The annual fiscal savings for the GoM from reduced subsidy requirement is estimated at 1,097,748 USD. The PV over project life amounts to 9.18 million USD. Moreover, the project led to positive environmental impacts due to reduced fertilizer consumption.

The analysis makes four key recommendations:

1. **Expand GoM subsidy of fertilizers.** The GoM provides a 50 percent subsidy on chemical fertilizer (Sikasso region) used for production of cotton, maize and rice. A significant number of project beneficiaries are expected to shift from cotton and maize production to the improved sorghum production, therefore, releasing fiscal pressure. It is recommended to include sorghum into the list of crops that can obtain subsidies on fertilizers. Such a measure will allow farmers to increase annual income from 115 to 134 USD/ha. This additional financial incentive will boost the scaling up dissemination of the production technologies.
2. **Assure access to hybrid and improved seed varieties.** The problem of cultural reluctance of farmers to purchase seeds for their production should be addressed by the project.¹⁴ Currently, the project provides free sorghum and millet seeds to attendants of field schools and farmers have limited exposure to purchasing seeds directly from the market. With Phase II, the project is expecting to improve access to high quality seeds by increasing seed production. Farmers, however, have only one farm period to begin purchasing seeds directly from the market before the anticipated project end date. This is a very short period for addressing any problems that may arise in this process and can potentially threaten sustainable access to new seed varieties.
3. **Facilitate coordination at the implementing partner level.** Coordination of activities between current project implementing partners is fairly weak, resulting in a “silo approach” to project implementation in certain areas, which can reduce efficiency and overall impact of project. In the 2014-15 farm year, there were instances of the same farmer in the Sikasso region receiving ARDT_SMS project

¹⁴ “Seed Value Chains for Sorghum and Millet in Mali”, International Food Policy Research Institute, 2008, pg 14-15. Farmers tend to use their own seeds based on history, culture and traditional knowledge. Farmers also tend to be generally risk averse in trying new methods without seeing results first and cash poor at the time of planting. These factors also influence decisions of producers to purchase seeds rather than use their own.

training from two different implementing partners on two different methodologies. This risk can be managed by introducing consultative platforms for partners working in the same region and at the lead implementing partner level (such as through ICRISAT).

4. **Leverage synergies with other projects carrying out similar work in the Sikasso and Mopti regions.** Adoption of new technologies requires a certain level of commitment by farmers to change current production practices. This commitment can only be obtained when farmers have access to all required inputs, including access to credit and access to markets to sell their production. Limited attention of the ARDT_SMS project on issues other than productivity raises major concerns.

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ANNEX A – LIST OF INTERVIEWED STAKEHOLDERS

Date	Location	Stakeholders
City of Bamako (December 1 – 4, 2015)		
Tuesday, December 1, 2015	ACI 2000	USAID In brief – David Yanggen (Director, Office of Economic Growth) & colleagues
Tuesday, December 1, 2015	Samanko	ICRISAT – John Nzungize (Principal Scientist)
Wednesday, December 2, 2015	MALIMARK/AC2000	MALIMARK – Tangara Aminata Coulibaly (National Director) & colleague
Wednesday, December 2, 2015	Rue Mohamed V	IER – Abdoul Karim Traoré (Director of Research) & colleague
Thursday, December 3, 2015	ACI 2000	CRS – Ousmane Maiga (Deputy Head of Programs)
Thursday, December 3, 2015	Immeuble Niangado (adjacent CICB)	AKF - Karim Sissoko (Regional Rural Development) & colleague
Friday, December 4, 2015	Avenue de l'OUA Faladié	SOGEA – Nonon Diarra (Director General)
Friday, December 4, 2015	Hamdallaye ACI 2000	EUCORD – Karamoko Sako (National Coordinator) & colleague
Sikasso Region (December 6 – 14, 2015)		
Sunday, December 6, 2015	Bougouni	Farmer's Cooperative (ARDT Beneficiaries) – Sidiki Sangare & colleagues
Monday, December 7, 2015	Sikasso	CMDT Sikasso – Abdul Maiga (Head of Research) & colleagues
Monday, December 7, 2015	Sikasso	AOPP – Oumar Sanogo (Coordinator, Sikasso Office) & colleagues
Monday, December 7, 2015	Sikasso	CRS – Aminata Coulibaly (Head of Program – ARDT) / DRA – Mr. Yaya (Head of Division & CRS POC) & colleagues

Date	Location	Stakeholders
Tuesday, December 8, 2015	Sikasso Commune: N'tobougou	N'tobougou Farmers' Cooperative (8 farmers present)
Tuesday, December 8, 2015	Sikasso Commune: Tabacoro	Tabacoro Women's Cooperative (5 farmers present)
Tuesday, December 8, 2015	Kaboïla Commune: Nayerebougou	Nayerebougou Farmers' Cooperative (7 farmers present)
Tuesday, December 8, 2015	Kaboïla Commune: Badabala	Badabala Farmer Group (11 farmers present)
Wednesday, December 9, 2015	Zégoua Commune: Nassoulou	Nassoulou Farmers' Cooperative (8 farmers present)
Wednesday, December 9, 2015	Zégoua Commune: Katele	Katele Farmers' Cooperative (8 farmers present)
Wednesday, December 9, 2015	Kadiolo Commune: Gninasso	Gninasso Farmers' Cooperative (7 farmers present)
Wednesday, December 9, 2015	Kadiolo Commune: Sama	Sama Farmers' Cooperative (8 farmers present)
Thursday, December 10, 2015	Kouoro Commune: Makono	Makono Farmers' Cooperative (5 farmers present)
Thursday, December 10, 2015	Kouoro Commune: Sougoula	Sougoula Farmers' Cooperative (4 farmers present)
Thursday, December 10, 2015	Gongasso Commune: Tabakoro	Tabakoro Farmers' Cooperative (5 farmers present)
Thursday, December 10, 2015	Gongasso Commune: N'tibougou	N'tibougou Farmers' Cooperative (4 farmers present)
Friday, December 11, 2015	Koutiala	CMDT Koutiala – Brema Diara (Head of Agriculture Production Division) & colleagues
Friday, December 11, 2015	Sinsina Commune: Napossela	Napossela Farmers' Cooperative (4 farmers present)

Date		Location	Stakeholders
Friday, December 11, 2015		Koutiala Bagnan Commune:	Bagnan Farmers' Cooperative (3 farmers present)
Saturday, December 12, 2015		Zangasso Zangasso Commune:	Zangasso Farmers' Cooperative (7 farmers present)
Saturday, December 12, 2015		Koutiala N'tosso Commune:	N'tosso Farmers' Cooperative (6 farmers present)
Monday, December 14, 2015		Klela Zerelani Commune:	Zerelani Farmers' Cooperative (6 farmers present)
Monday, December 14, 2015		Klela N'jirikoro Commune:	N'jirikoro Farmers' Cooperative (5 farmers present)
Monday, December 14, 2015		Sikasso	UNRIA – Souleymane Dambele (President for Sikasso Region) & colleagues
City of Bamako (December 15 – 18, 2015)			
Tuesday, December 15, 2015		Samanko	ICRISAT – John Nzungize (Principal Scientist)
Wednesday, December 16, 2015		Hamdallaye ACI 2000	Kafo Jigenew – Ibrahima Keita (Deputy Director) & colleague
Wednesday, December 16, 2015		Hamdallaye ACI 2000	BNDA – Bassirou Diarra (Head, SME Services)
Wednesday, December 16, 2015		Sogoniko	TOGUNA Agro-Industries – Hamat Macina (Internal Controls / SMQ)
Wednesday, December 16, 2015		Kalaban Coura	AOPP – Oumar Coumaré (Coordinator, ARDT Project)
Thursday,		Niamakoro Cité	CVC Project – Willem Van Campen (Chief

Date	Location	Stakeholders
December 17, 2015	UNICEF	of Party) & colleagues
Thursday, December 17, 2015	ACI 2000	USAID Outbrief – David Yanggen (Director, Office of Economic Growth) & colleagues
Friday, December 18, 2015	Badalabougou	WFP – Ali Abdul Salim (Project Coordinator) and Nouhou Cissé (M&E Officer)
Mopti Region by phone (December 16 – 18, 2015)		
Wednesday, December 16, 2015	Dourou Commune: Kourou-Tangui	Boureima Issa SAGARA (ARDT project farmer)
Friday, December 18, 2015	Sio Kalamani Commune:	Jean BORE (ARDT project farmer)
Friday, December 18, 2015	Koporona Commune: Kountagoro	El Hadj Oumar TOGO (ARDT project farmer)

ANNEX B – LIST OF COMMODITY SPECIFIC CONVERSION FACTORS

Seeds (importable input)	0.85
Maize, sorghum, millet, and cowpeas (importable output)	0.84
Fertilizer for millet and maize (exportable input)	2.04
Fertilizer for other crops (exportable input)	1.07
Fungicide and herbicide (importable input)	0.98
Sacks (importable input)	0.75
Agricultural equipment (importable input)	0.98
Labor	1.00
Cowpea's residues	1.00
Organic manure	1.00

ANNEX C – INDICATIVE LOCAL MILLET FARM BUDGETS

Item	Quantity	Value per Unit (XOF)	XOF/Ha
Revenues			
Millet (Kg/Ha)	930	155	144,150
Total Revenues			144,150
Costs			
Cost of Inputs			
Seeds (recycled) – millet	8	190	1,520
Fertilizer – organic manure	2,500	3	7,500
Fertilizer – cereal complex	25	220	5,500
Fertilizer – urea	25	220	5,500
Fungicide – local product	2	500	1,000
Total cost of Inputs			21,020
Cost of Labor			
Cleaning plots	6	1,250	7,500
Sowing	12	1,250	15,000
Weeding	20	1,250	25,000
Application of chemical fertilizer	1	1,250	1,250
Application of organic manure	40	750	30,000
Harvesting millet	10	1,250	12,500
Threshing and winnowing	10	1,250	12,500
Total cost of labor			103,750
Other Costs			
Sacks	9	75	675
Transportation	9	300	2,700
Total other costs			3,375

Total Costs			128,145
Net Income			16,005

ANNEX D – INDICATIVE IMPROVED MILLET FARM BUDGETS

Item	Quantity	Value per Unit (XOF)	XOF/Ha
Revenues			
Millet (Kg/Ha)	1,200	155	186,000
Cowpeas (Kg/Ha)	200	234	46,800
Cowpeas residues (Bundle/Ha)	35	75	2,625
Total Revenues			235,425
Costs			
Cost of Inputs			
Seeds (improved) – millet	4	1,250	5,000
Seeds (improved) – cowpeas	8	1,000	8,000
Fertilizer – organic manure	2,500	3	7,500
Fertilizer – cereal complex	35	220	7,700
Fertilizer – urea	35	220	7,700
Fungicide – Apron star	1	1,200	1,200
Total cost of Inputs			37,100
Cost of Labor			
Cleaning plots	6	1,250	7,500
Sowing	16	1,250	20,000
Weeding	10	1,250	12,500
Application of chemical fertilizer	6	1,250	7,500
Application of organic manure	40	750	30,000
Harvesting millet	13	1,250	16,250
Harvesting cowpeas	8	1,250	10,000
Threshing and winnowing	13	1,250	16,250
Total cost of labor			120,000

Other Costs			
Sacks	12	75	900
Transportation	12	300	3,600
<i>Total other costs</i>			4,500
Total Costs			161,600
Net Income			73,825

ANNEX E – INDICATIVE MAIZE FARM BUDGETS

Item	Quantity	Value per Unit (XOF)	XOF/Ha
Revenues			
Maize (Kg/Ha)	2,400	103	247,200
Total Revenues			247,200
Costs			
Cost of Inputs			
Seeds (recycled) – maize	25	150	3,750
Fertilizer – organic manure	5,000	5	25,000
Fertilizer – cereal complex	100	233	23,300
Fertilizer – urea	100	233	23,300
Herbicide – preemergence	3	4,650	13,950
Fungicide – Apron star	1	1,200	1,200
Total cost of Inputs			
Cost of Labor			
Cleaning plots	5	1,250	6,250
Application of chemical fertilizer	2	1,250	2,500
Application of herbicide	1	1,250	1,250
Application of organic manure	5	1,250	6,250
Harvesting maize	15	1,250	18,750
Removing husks and winnowing	25	1,250	31,250
Transportation	5	1,250	6,250
Total cost of labor			72,500
Other Equipment			
Herbicide pump	0.2	12,500	2,500
Total cost of equipment			2,500
Price for Services			
Soil plowing cost	1	20,000	20,000
Sowing cost	1	5,000	5,000

ANNEX F – INDICATIVE LOCAL SORGHUM FARM BUDGETS

Item	Quantity	Value per Unit (XOF)	XOF/Ha
Revenues			
Sorghum (Kg/Ha)	1,000	120	120,000
Total Revenues			120,000
Costs			
Cost of Inputs			
Seeds (recycled) – sorghum	8	150	1,200
Fertilizer – cereal complex	20	233	4,660
Herbicide – total	2	3,750	7,500
Total cost of Inputs			13,360
Cost of Labor			
Cleaning plots	5	1,250	6,250
Sowing	5	1,250	6,250
Application of chemical fertilizer	0.25	1,250	313
Application of herbicide	1	1,250	1,250
Harvesting sorghum	10	1,250	12,500
Threshing and winnowing	10	1,250	12,500
Transportation	2	1,250	2,500
Total cost of labor			41,563
Other Equipment			
Herbicide pump	0.2	12,500	2,500
Total cost of equipment			2,500
Price for Services			
Soil plowing cost	1	10,000	10,000
Weeding cost	1	25,000	25,000
Mounding cost	1	10,000	10,000
Total cost of services			45,000

ANNEX G – INDICATIVE IMPROVED SORGHUM FARM BUDGETS

Item	Quantity	Value per Unit (XOF)	XOF/Ha
Revenues			
Sorghum (Kg/Ha)	1,600	120	192,000
Cowpeas residues (Bundle/Ha)	800	75	60,000
Total Revenues			252,000
Costs			
Cost of Inputs			
Seeds – sorghum	6	1,500	9,000
Seeds – cowpeas	8	1,500	12,000
Fertilizer – cereal complex	35	440	15,400
Fertilizer – urea	17	440	7,480
Herbicide – total	2	3,750	7,500
Fungicide – Apron star	1	1,200	1,200
Total cost of Inputs			52,580
Cost of Labor			
Cleaning plots	5	1,250	6,250
Sowing	8	1,250	10,000
Application of chemical fertilizer	8	1,250	10,000
Application of herbicide	1	1,250	1,250
Harvesting sorghum	8	1,250	10,000
Threshing and winnowing	12	1,250	15,000
Transportation	4	1,250	5,000
Total cost of labor			57,500
Other Equipment			
Herbicide pump	0.2	12,500	2,500
Total cost of equipment			2,500
Price for Services			

Soil plowing cost	1	20,000	20,000
Weeding cost	1	37,500	37,500
Mounding cost	1	11,250	11,250
<i>Total cost of services</i>			68,750
Other Costs			
Sacks	16	75	1,200
<i>Total other costs</i>			1,200
Total Costs			110,080
Net Income			141,920

ANNEX H – SOURCES OF INPUTS

General Inputs	
Input	Source
Periodical replacement of herbicide pump (Cell F55)	<input type="checkbox"/> Interviews with farmers
Number of hectares under improved technologies, M&E targets (Cell I66 to L66)	<input type="checkbox"/> M&E data of the project
Share of different regions (Cell F67 to F68)	<input type="checkbox"/> Assumption
Cost of labor (Cell F71 to F72)	<input type="checkbox"/> Interviews with farmers
Local Millet Production (Without Project)	
Input	Source
In-house consumption (Cell F84)	<input type="checkbox"/> Interviews with farmers <input type="checkbox"/> FAO Recommendation
Millet sold (Cell F85 to F86)	<input type="checkbox"/> Function of the yield and in-house consumption
Initial yield of local millet (Cell F89)	<input type="checkbox"/> Interviews with farmers
Price of millet (Cell F90 to F91)	<input type="checkbox"/> Interviews with farmers <input type="checkbox"/> CRS
Weighted average price of millet (Cell F92)	<input type="checkbox"/> Function of prices and weights
Input requirements (Cell F99 to F105)	<input type="checkbox"/> Interviews with farmers <input type="checkbox"/> CRS
Cost of inputs (Cell F108 to F114)	<input type="checkbox"/> Interviews with farmers <input type="checkbox"/> CRS
Labor requirement (Cell F120 to F127)	<input type="checkbox"/> Interviews with farmers <input type="checkbox"/> CRS
Number of sacks required (Cell F129)	<input type="checkbox"/> Function of yield
Price of sacks (Cell F130)	<input type="checkbox"/> Interviews with farmers

Transportation fee (Cell F131)	<input type="checkbox"/> Interviews with farmers
Improved Millet Production (With Project)	
Input	Source
In-house consumption (Cell F139)	<input type="checkbox"/> Interviews with farmers <input type="checkbox"/> FAO Recommendation
Millet sold (Cell F140 to F141)	<input type="checkbox"/> Function of the yield and in-house consumption
% change in yield of millet (Cell F142)	<input type="checkbox"/> Interviews with farmers
yield of improved millet (Cell F143)	<input type="checkbox"/> Function of % change in yield
Price of millet (Cell F144 to F145)	<input type="checkbox"/> Interviews with farmers <input type="checkbox"/> CRS
Weighted average price of millet (Cell F146)	<input type="checkbox"/> Function of prices and weights
In-house consumption (Cell F148)	<input type="checkbox"/> Interviews with farmers <input type="checkbox"/> CRS
Yield of cowpeas (Cell F140)	<input type="checkbox"/> Interviews with farmers
Price of cowpeas (Cell F151 to F152 and F153)	<input type="checkbox"/> Interviews with farmers <input type="checkbox"/> CRS
Residue of cowpeas (Cell F154)	<input type="checkbox"/> Interviews with farmers
Input requirements (Cell F157 to F163)	<input type="checkbox"/> Interviews with farmers <input type="checkbox"/> CRS
Cost of inputs (Cell F166 to F167)	<input type="checkbox"/> Interviews with farmers
Labor requirement (Cell F178 to F185)	<input type="checkbox"/> Interviews with farmers <input type="checkbox"/> CRS
Number of sacks required (Cell F187)	<input type="checkbox"/> Function of yield
Price of sacks (Cell F188)	<input type="checkbox"/> Interviews with farmers
Transportation fee (Cell F189)	<input type="checkbox"/> Interviews with farmers
Maize Production (Without Project)	
Input	Source

Share of maize/sorghum (Cell I96 to I97)	<input type="checkbox"/> Assumption based on field visit and DRA statistics
In-house consumption (Cell F204)	<input type="checkbox"/> Interviews with farmers <input type="checkbox"/> FAO Recommendation
Maize sold (Cell F205 to F206)	<input type="checkbox"/> Function of the yield and in-house consumption
Yield growth rate (Cell F207)	<input type="checkbox"/> Assumption
Maximum yield achievable (Cell F208)	<input type="checkbox"/> Assumption
Initial yield of maize (Cell F209)	<input type="checkbox"/> Interviews with farmers <input type="checkbox"/> CRS <input type="checkbox"/> CMDT <input type="checkbox"/> DRA
Price of maize (Cell F210 to F211)	<input type="checkbox"/> Interviews with farmers <input type="checkbox"/> CRS
Weighted average price of millet (Cell F212)	<input type="checkbox"/> Function of prices and weights
Input requirements (Cell F219 to F226)	<input type="checkbox"/> Interviews with farmers <input type="checkbox"/> CRS <input type="checkbox"/> CMDT
Cost of inputs (Cell F229 to F236)	<input type="checkbox"/> Interviews with farmers <input type="checkbox"/> Interviews with agro dealers <input type="checkbox"/> UNRIA and Malimark
Labor requirement (Cell F241 to F249)	<input type="checkbox"/> Interviews with farmers <input type="checkbox"/> CRS
Herbicide pump (Cell F251)	<input type="checkbox"/> Interviews with farmers
Pumps required (Cell F252)	<input type="checkbox"/> Interviews with farmers <input type="checkbox"/> CMDT
Price of services (Cell F254 to F257)	<input type="checkbox"/> Interviews with farmers
Number of sacks required (Cell F259)	<input type="checkbox"/> Function of yield
Price of sacks (Cell F260)	<input type="checkbox"/> Interviews with farmers
Local Sorghum Production (Without Project)	
Input	Source
In-house consumption (Cell F273)	<input type="checkbox"/> Interviews with farmers

	<input type="checkbox"/> FAO Recommendation
Sorghum sold (Cell F274 to F275)	<input type="checkbox"/> Function of the yield and in-house consumption
Initial yield of local sorghum (Cell F278)	<input type="checkbox"/> Interviews with farmers <input type="checkbox"/> CRS <input type="checkbox"/> CMDT <input type="checkbox"/> DRA
Price of sorghum (Cell F279 to F280)	<input type="checkbox"/> Interviews with farmers <input type="checkbox"/> CRS
Weighted avg. price of millet (Cell F281)	<input type="checkbox"/> Function of prices and weights
Input requirements (Cell F288 to F295)	<input type="checkbox"/> Interviews with farmers <input type="checkbox"/> CRS <input type="checkbox"/> CMDT
Cost of inputs (Cell F298 to F305)	<input type="checkbox"/> Interviews with farmers <input type="checkbox"/> Interviews with agro dealers <input type="checkbox"/> UNRIA and Mali mark
Labor requirement (Cell F310 to F318)	<input type="checkbox"/> Interviews with farmers <input type="checkbox"/> CRS
Herbicide pump (Cell F320)	<input type="checkbox"/> Interviews with farmers
Pumps required (Cell F321)	<input type="checkbox"/> Interviews with farmers <input type="checkbox"/> CMDT
Price of services (Cell F323 to F326)	<input type="checkbox"/> Interviews with farmers
Price of sacks (Cell F328)	<input type="checkbox"/> Interviews with farmers
Improved Sorghum Production (With Project)	
Input	Source
In-house consumption (Cell F337)	<input type="checkbox"/> Interviews with farmers <input type="checkbox"/> FAO Recommendation
Sorghum sold (Cell F338 to F339)	<input type="checkbox"/> Function of the yield and in-house consumption
yield of improved sorghum (Cell F341)	<input type="checkbox"/> Interviews with farmers <input type="checkbox"/> CRS <input type="checkbox"/> CMDT
Price of sorghum (Cell F342 to F343)	<input type="checkbox"/> Interviews with farmers <input type="checkbox"/> CRS

Weighted avg. price of millet (Cell F344)	<input type="checkbox"/> Function of prices and weights
Residues of cowpeas (Cell F349)	<input type="checkbox"/> Interviews with farmers <input type="checkbox"/> CRS
Input requirements (Cell F352 to F359)	<input type="checkbox"/> Interviews with farmers <input type="checkbox"/> CRS <input type="checkbox"/> CMDT
Price of fertilizers (Cell F362 to F363)	<input type="checkbox"/> Interviews with farmers <input type="checkbox"/> CRS <input type="checkbox"/> Interviews with agro dealers <input type="checkbox"/> UNRIA and Mali mark
Cost of inputs (Cell F366 to F368 and F371 to F373)	<input type="checkbox"/> Interviews with farmers <input type="checkbox"/> Interviews with agro dealers <input type="checkbox"/> UNRIA and Mali mark
Price of Fertilizers (Cell F369 to F370)	<input type="checkbox"/> Function of subsidy switch (Cell F359) <input type="checkbox"/> Interviews with agro dealers <input type="checkbox"/> UNRIA and Mali mark
Labor requirement (Cell F378 to F386)	<input type="checkbox"/> Interviews with farmers <input type="checkbox"/> CRS
Herbicide pump (Cell F388)	<input type="checkbox"/> Interviews with farmers
Pumps required (Cell F389)	<input type="checkbox"/> Interviews with farmers <input type="checkbox"/> CMDT
Price of services (Cell F391 to F394)	<input type="checkbox"/> Interviews with farmers
Price of sacks (Cell F396)	<input type="checkbox"/> Interviews with farmers
Macroeconomic Indicators	
Input	Source
US inflation rate (Cell F399)	<input type="checkbox"/> IMF
Price index – US (Cell F400)	<input type="checkbox"/> Function of US inflation
Mali inflation rate (Cell F401)	<input type="checkbox"/> IMF
Price index – Mali (Cell F402)	<input type="checkbox"/> Function of Mali inflation
Relative Price Index (Cell F403)	<input type="checkbox"/> Function of US and Mali price index
Official nominal exchange rate (Cell I404 to J404)	<input type="checkbox"/> World Bank (http://data.worldbank.org/indicator/PA)

	.NUS.FCRF)
Real exchange rate (Cell F405)	<input type="checkbox"/> 2015 is the base year, so the nominal exchange rate equals the real exchange rate.
Nominal exchange rate (Row 407)	<input type="checkbox"/> Function of real exchange rate and relative price index
Discount rate (Cell F408)	<input type="checkbox"/> USAID guidelines
EOCK (Cell F409)	<input type="checkbox"/> USAID guidelines
USAID investment cost (Cell I412 to L412)	<input type="checkbox"/> M&E data of the project
Share of regions from the budget (Cell F413)	<input type="checkbox"/> Assumption